PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B02C 18/14, 4/30

A1

(11) International Publication Number: WO 98/58739

(43) International Publication Date: 30 December 1998 (30.12.98)

(21) International Application Number: PCT/GB98/01811

(22) International Filing Date: 19 June 1998 (19.06.98)

(30) Priority Data:

9713163.5	23 June 1997 (23.06.97)	GB
9720390.5	26 September 1997 (26.09.97)	GB

(71) Applicant *(for all designated States except US)*: MMD DESIGN & CONSULTANCY LIMITED [GB/GB]; Cotes Park Lane, Cotes Park Industrial Estate, Somercotes, Derbyshire DE55 4NJ (GB).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: POTTS, Alan [GB/GB]; MMD Design & Consultancy Limited, Cotes Park Lane, Cotes Park Industrial Estate, Somercotes, Derbyshire DE55 4NJ (GB).

(74) Agent: DEALTRY, Brian; Eric Potter Clarkson, Park View House, 58 The Ropewalk, Nottingham, NG1 5DD (GB).

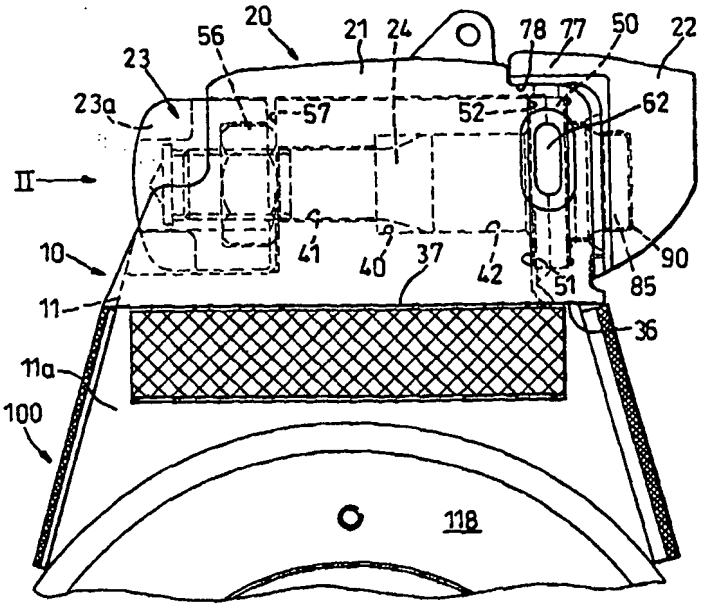
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: MINERAL BREAKER

(57) Abstract

A tooth construction for a mineral breaker of the type having at least one breaker drum from which breaker teeth project, the drum being rotatable in a given direction to effect breakage of mineral, the tooth construction (10) including a tooth core (11) upon which is mounted a tooth cap assembly (20), the tooth core (11) having a terminal end having opposed front and rear faces (52, 57) spaced along said given direction and a bore (40) extending between said front and rear faces, the tooth cap assembly (20) including an anchor member (24) extending along and being immovably connected to the core (11) by being held under a tensile loading by clamping abutment against said front and rear faces, the anchor member having first and second mounting portions which project beyond said front and rear faces respectively, the tooth cap assembly (20) further including a tooth cap (21) which overlies the terminal end of the core (11) which extends between said front and rear faces, the tooth cap (21) being immovably secured to said first and second mounting portions.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

MINERAL BREAKER

The present invention relates in particular, but not exclusively, to a tooth construction for use in a mineral breaker and a mineral breaker including a breaker drum having replaceable teeth.

The invention is, in particular, concerned with mineral breakers of the type described in our patents GB 2170424, EP 0096706 and EP 0167178 in which mineral is broken by a snapping action.

In mineral breakers of this type a pair of breaker drums are provided in which individual teeth project generally radially from the axis of the drum and each drum is rotated in a given direction in order to effect breakage of mineral.

The tooth construction described in the above patents includes a tooth core in the form of an arm which projects generally radially from the axis and a sheath or tooth cap which covers the tooth core.

The core or arm is made from an impact resistant cast metal and the sheath or cap is made of a wear resistant material such as a high manganese content steel or a suitable steel alloy depending upon the mineral to be broken.

When the tooth sheath has worn it is necessary to replace the entire sheath. This can be a time consuming operation, particularly with large mineral breakers.

It will be appreciated that in use a tooth sheath will be exposed to repetitive impacts and high loads and so any movement between the sheath and core will quickly lead to failure of the tooth.

It is a general aim of the present invention to provide a tooth construction for such mineral breakers wherein a tooth sheath is securely held in place and yet wherein worn breaker teeth can be easily renewed.

According to one aspect of the present invention there is provided a tooth construction for a mineral breaker of the type having at least one breaker drum from which breaker teeth project, the drum being rotatable in a given direction to effect breakage of mineral, the tooth construction including a tooth core upon which is mounted a tooth cap assembly, the tooth core having a terminal end having opposed front and rear faces spaced along said given direction and a bore extending between said front and rear faces, the tooth cap assembly including an anchor member extending along and being immovably connected to the core by being held under a tensile loading by clamping abutment against said front and rear faces, the anchor member having first and second mounting portions which project beyond said front and rear faces respectively, the tooth cap assembly further including a tooth cap which overlies the terminal end of the core which extends between said front and rear faces, the tooth cap being immovably secured to said first and second mounting portions.

If the material of the tooth cap is a steel alloy which has the capability of resisting deformation occurring from repeated impacts, then it is envisaged that in accordance with one embodiment, the tooth cap may

comprise a clamping face for clamping the anchor member to the core. If the material of the tooth cap tends to deform, ie. cold flow, under repeated impacts, it is envisaged that in accordance with a further embodiment of the invention that the tooth cap is isolated from the clamping abutment between the anchor member and the core.

According to another aspect of the present invention there is provided a tooth construction for a mineral breaker of the type having at least one breaker drum from which breaker teeth project, the drum being rotatable in a given direction to effect breakage of mineral, the tooth construction including a tooth core upon which is mounted a tooth cap assembly, the tooth core having a terminal end having opposed front and rear faces spaced along said given direction and a bore extending between said front and rear faces, an anchor removably located in said bore, the anchor including a mounting portion which projects beyond said front face, the anchor having a clamping face held in clamping abutment with said front face by clamping means co-operating with said anchor so as to rigidly connect said mounting portion to said tooth core, the tooth cap assembly further including a tooth cap which covers said terminal end between said front and rear faces, the tooth cap being fixedly secured to said mounting portion.

Preferably the anchor includes a shank portion integrally formed with said mounting portion, the mounting portion comprising a collar formed on said shank portion, the clamping face being defined by one axial side face of said collar.

Preferably the clamping means comprises a screw threaded portion formed on said shank portion at an axial location spaced from said collar

and a nut located on said screw threaded portion, the nut being arranged to clampingly engage against said rear face.

Preferably the shank portion is formed from a high tensile metal, such as high tensile steel, so that a high clamping force may be applied to said clamping face.

Preferably said anchor has a rear mounting portion which projects rearwardly of said rear face and said tooth cap being fixedly secured to said rear mounting portion.

Preferably the tooth cap is provided with a detachable tooth cap tip.

Preferably the tooth core is in the form of a radially projecting arm formed on the breaker drum, the arm being preferably cast from an impact resistant metal, such as alloy steel.

According to another aspect of the present invention there is provided a mineral breaker including one or more tooth constructions as defined above.

According to another aspect of the present invention there is provided a method of constructing a tooth construction as defined above, the method comprising clamping the anchor to a tooth core, and subsequently fixedly connecting the tooth cap to the mounting portion of the anchor.

Various aspects of the present invention will be hereinafter described

with reference to the accompanying drawings in which:-

Figure 1 is a side view of an assembled breaker tooth construction according to a first embodiment of the present invention;

Figure 2 is an end view of the construction shown in Figure 1 taken in direction II;

Figure 3 is a plan view of the tooth cap main body;

Figure 4 is a sectional view along line IV-IV in Figure 3;

Figure 5 is an end view taken in direction V in Figure 3;

Figure 6 is a plan view of the tooth cap assembly removed from the tooth core;

Figure 7 is a view taken along direction VII in Figure 6;

Figure 8 is a side view of the anchor member;

Figure 9 is and end view taken in direction IX in Figure 8;

Figure 10 is a plan view of the tooth cap tip;

Figure 11 is an end view taken along direction XI in Figure 10;

Figure 12 is a side view of the tooth cap tip shown in Figure 12;

Figure 13 is an end view of the rear cover taken in direction II in Figure 1;

Figure 14 is a schematic side view, partly in section, of a modified version of the first embodiment;

Figure 15 is a side view of an assembled breaker tooth construction according to a second embodiment of the present invention;

Figure 16 is an end view of the construction shown in Figure 15 as viewed in the direction of arrow XV;

Figure 17 is a sectional view taken along line XVI-XVI in Figure 15;

Figure 18 is an exploded side view of the construction shown in Figure 15; and

Figure 19 is an end view of a pair of breaker drums including teeth as shown in Figure 15.

Referring initially to Figures 1 and 2 there is shown a first embodiment of an assembled tooth construction 10 which includes a tooth core 11 upon which is mounted a tooth cap assembly 20. The tooth core 11 forms part of a breaker drum ring assembly 100 each of which includes a plurality of radially directed arms 11a (preferably 3 or 4) extending from an annular portion 118. In use a plurality of ring assemblies are mounted side by side on a shaft to define a breaker drum as described in patent specifications EP 0096706 and GB 2170424 to which reference should be made. In the first embodiment, the tooth core 11 is defined by the terminal end of an arm 11a.

In the first embodiment, the tooth cap assembly 20 includes a main body 21, a tip 22, a rear cover 23 and an anchor 24.

Preferably, as more clearly seen in Figures 3 to 7, the body 21 is generally hollow having a central elongate channel shaped recess 28.

The body 21 includes opposed side walls 29, 30 which define opposed sides of the channel shaped recess 28 and an upper wall 32 which defines the bottom of the channel shaped recess 28. Preferably as shown in Figures 2, 7, opposed side walls 29, 30 are generally planar and upper wall 32 is curved, being preferably part circular in cross-section.

The front axial end of the channel shaped recess 28 is closed by an end wall 33.

The opposite axial end of the channel shaped recess 28 is open.

The tooth core 11 has opposed outer side walls 11b, 11c and a curved upper outer wall 11d. Walls 11b, c and d are preferably configured and sized so as to closely lie adjacent to the internal faces of walls 29, 30 and 32.

Preferably the tooth core 11 has a pair of shoulders 36 which are preferably rectilinear as shown in Figure 1. Preferably the main body 21 has rectilinear end faces 37 formed on walls 29, 30 which seat upon shoulders 36. Shoulders 36 and/or faces 37 may be finished by machining in order to provide an accurate fit.

The tooth core 11 is provided with a through bore 40 in which is received the anchor 24.

Preferably, as shown, the anchor 24 is in the form of a spigot having a stepped shank 44. The shank 44 includes a relatively large diameter portion 45 and a relatively small diameter portion 46.

The through bore 40 is similarly stepped having a large diameter portion 42 and a small diameter portion 41.

Preferably the large shank diameter portion 45 and bore diameter portion 42 are manufactured to be of substantially the same diameter so as to provide an accurate fit which resists displacement of the spigot radially relative to the bore 40.

A tooth cap mounting collar 50 is formed on the large diameter portion 45 and is provided with an accurately machined axial end face 51 which defines a clamping face for abutment against an accurately machined forwardly facing end face 52 formed on the tooth core 11.

The small diameter shank portion 46 projects rearwardly from the tooth core 11 and is provided with an external screw thread 46a.

A nut 56 is received on screw thread 46a and is tightened to abut the rearwardly facing end face 57 of tooth core 11. Tightening of nut 56 places the shank under tension and pulls faces 51, 52 into clamping abutment and in effect clampingly engages the spigot with the front and rear end faces 52, 57 respectively of the tooth core 11.

Both faces 52 and 57 are preferably accurately formed by machining and are preferably planar and located in a plane substantially perpendicular to the axis of anchor 24. Accordingly the metal from which tooth core 11 is formed is preferably readily machinable as well as being impact resistant. An alloy steel is a suitable metal.

Preferably the spigot is formed from a high tensile steel, preferably by forging, such that a high tensile load can be applied by nut 56. This ensures that the spigot is immovably anchored to the tooth core 11 and will remain so during use when the tooth construction will be exposed to repeated high impact forces.

A modification to the anchor 24 and tooth core 11 is illustrated in Figure

14 whereby the anchor 24 and core 11 are adapted to co-operate with one another in order to prevent rotation of the anchor 24 within bore 40.

In this respect, the leading face of the tooth core 11 is provided with an annular projection 111 which is accurately machined to define a diametrically extending recess 112.

The rearwardly facing face of the collar 50 is also accurately machined to define a pair of spaced shouldered recesses 114 which define therebetween an axially projecting projection 115.

The opposed radially facing faces 116,117 of the collar 50 and projection 111 interact to prevent rotation of the anchor 24 on tightening of the nut 56. Accordingly after cap assembly 20 has been secured to the anchor 24, the cap assembly 20 is securely prevented from movement relative to the core 11 about the axis of the bore 40.

The main body 21 includes a circular recess 60 formed in end wall 33 in which collar 50 is located when the main body 21 is seated upon the tooth core 11. The main body 21 is provided with a series of openings 62 which as shown in Figure 1 overlie the collar 50. The openings 62 enable the body 21 to be fixedly secured to the collar 50 by suitable fixing techniques such as welding. Preferably, at least adjacent the lower region of recess 60, the wall 33 is provided with a groove 80a (Figures 4 and 7) to facilitate welding of the collar 50 to the inside of wall 33.

A tooth cap tip 22 is located on the front end of the main body 21. The

tip 22 has an internal face 70 which in use is in abutment with the external front face 72 of main body 21. A locating rib 73 projects rearwardly from the lower region of face 70 and is received within a co-operating recess 76 formed in the lower region of face 72 of body 21.

A flange 77 protrudes rearwardly from the upper region of internal face 70 and extends over the upper region 74 of main body 21, preferably as shown in Figure 1, by a distance sufficient to cover openings 62 located in the upper region of the main body.

Preferably the upper region 74 is recessed to accommodate flange 77. The flange 77 has an internal face 78 which is seated upon the upper region 74 so that, in use, impact loadings on the flange are transmitted to the main body 21.

The tip 22 and body 21 are preferably fixedly secured together by welding. To facilitate welding, the tip 22 and/or body 21 are formed so as to define grooves 80 extending along selected portions or all of the exposed mating abutment joint between faces 70, 72.

Preferably the anchor 24 is provided with a shank portion 85 which projects forwardly from the collar 50 and which extends through an aperture 87 formed in end wall 33.

The internal face 70 of the tip 22 is provided with a recess 90 into which shank portion 85 projects to provide additional support for the tip 22.

A rear cover 23 is located upon the screw thread 46a and is preferably

tightened so as to tightly abut the nut 56. In this respect the cover 23 also functions as a lock nut to resist loosening of nut 56. To facilitate gripping of the cover 23 to enable it to be turned for tightening, the cover 23 is preferably provided with a series of apertures 23a for receipt of a tool.

Preferably the cover 23 is fixedly secured to the main body 21 by suitable fixing techniques, such as welding. Such fixing prevents the cover 23 from loosening on the screw thread 46a and also fixedly and immovably connects the rear end of the main body 21 to the rear end of the anchor 24. Accordingly, with such an arrangement, the main body 21 is fixedly and immovably secured at both its front and rear ends to mounting portions on the anchor 24 which projects forwardly and rearwardly respectively from the bore 40 (viz the collar 50 and the thread portion 46a respectively).

Accordingly it will be appreciated that the tooth cap main body 21 in effect defines a bridge extending between the front and rear ends of the anchor 24 and is immovably secured at respective ends thereto. Since the anchor 24 is immovably secured to the tooth core 11, the tooth cap main body 21 is similarly immovably secured to the core 11.

Preferably, the main body 21, tip 22 and rear cover 23 are each in the form of casting cast from suitable metals. Since the main body 21, tip 22 and rear cover 23 are separate components, they may be cast from the same or different metals.

Preferably, in particular for the breaking of hard minerals, it is

envisaged that the main body 21, tip 22 and rear cover 23 will be cast from a metal exhibiting good wear resistant characteristics. Preferably such a metal is steel having a high manganese content.

It is known that high manganese content steel tends to cold flow when exposed to repeated impacts. However with the first embodiment illustrated in Figures 1 to 14 of the present invention, such flow is permitted without detriment to the securance of the tooth cap to the core 11 since such flow has no affect on the co-operation between the anchor 24 and the core 11.

It is envisaged that, in use, wear will primarily occur on the tip 22. Accordingly once excessive wear has occurred on the tip, it is envisaged that the worn tip 22 may be removed by removal of the welding in grooves 80 and that a new tip 22 may be fixed onto the main body 21.

This means that only a relatively small component (the tip 22) has to be replaced and that the remainder of the tooth assembly (the main body 21, rear cover 23 and anchor 24) remain in situ during the replacement operation.

It is however envisaged that the cap tip 22 and main body 21 may be formed together in one-piece such that the tip 22 and body 21 are not separable.

The tooth construction of the first embodiment is preferably constructed in the following sequence.

The anchor 24 is initially located in bore 40 and is clampingly anchored therein by a nut 56.

A cap body 21 is then located upon the tooth core 11 and urged downwardly so that the body 21 is properly seated on the tooth core 11. The body is also urged in a rearward direction to ensure that end face 50a is in abutment with end face 60a of recess 60.

The body 21 is then fixedly secured to the collar 50, preferably by welding, through openings 62.

A tooth cap tip 22 is now located upon the front of cap body 21 and is preferably fixedly secured thereto by tack welding.

Preferably the nut 56 is now removed to enable the partly assembled tooth construction to be removed from the tooth core.

The tooth body 21 and tip 22 are now fully welded together along grooves 80 and at least the bottom region of collar 50 is welded to the inside of body 21 along groove 80a.

The partly assembled tooth construction is now mounted upon a tooth core 11 and nut 56 is fully tightened.

Cover 23 is now screwed onto the threaded portion 46a and is fully tightened. The cover 23 is then fixedly secured to body 21 by welding.

A second embodiment according to the present invention is illustrated in

Figures 15 to 19 wherein parts similar to those in the first embodiment have been designated by the same reference numerals.

Referring initially to Figure 19 there is shown a pair of side by side breaker drum assemblies 300 each having a drive shaft 301 on which are keyed a series of annuli 218. The annuli 218 on each shaft 301 are arranged side by side and in face to face contact with one another along the shaft 301.

The annuli 218 are each provided with a plurality of breaker teeth constructions 200 spaced about their circumference. In Figure 19, each annulus 218 is provided with 6 teeth constructions 200, but it is to be appreciated that the number of tooth constructions provided may be more or less than 6.

Unlike the first embodiment, the tooth core 11 is directly formed on the periphery of the annulus 218. The outer periphery of the annulus 218 is defined by flat surfaces 217 which as seen in Figure 19 define a hexagonal configuration. Each flat surface 217 defines the rectilinear face 36 for co-operation with the rectilinear face 37 on the tooth cap main body 21.

Preferably as seen in Figures 16 & 17 the opposed walls 29,30 of the main body 21 are provided with inwardly directed flanges 121 which are received in grooves 111 formed in the tooth core 11. The flanges 121 and grooves 111 co-operate to assist in keying the tooth cap to the tooth core 11. It will be appreciated that similar flanges 121 and grooves 111 may be provided in the first embodiment.

The closed end of the channel shaped recess 28 in main body 21 is defined by an accurately machined end face 251. A screw threaded bore 260 is located centrally relative to face 251.

The anchor 24 is in the form of a threaded bolt having a shank 122 having a bolt head 124 at one end and a threaded portion 126 at the other end. The head 124 has an accurately formed abutment face 125 for abutment with face 57 of the tooth core 11.

In use the main body 21 is slid onto the tooth core 11 until end face 251 abuts face 52. The bolt is inserted into bore 40 and threaded portion 126 is screwed into bore 260. The bolt is tightened so as to clampingly abut faces 125 and 251 into contact with faces 57,52 respectively and place the shank under a desired tensile loading. The head 124 is then immovably connected to the tooth body 21 by suitable bonding techniques such as welding.

In the second embodiment the main body 21 and tip 22 are formed in one piece from a metal which is resistive to cold flow under impacts, such as a suitable steel alloy. Accordingly in the second embodiment it is possible to utilise the tooth cap main body 21 for clamping of the anchor 24.

Preferably as seen in Figures 16 & 17 the outer sides of the opposed walls 29,30 are shaped so as to have side faces 225,226 which are contiguous with side faces 219,220 of the annulus 218 on which it is mounted. This enables tooth caps on neighbouring annuli to reside in

close side by side proximity and effectively cloak the majority of the outer surfaces of the annuli 218. Preferably the outer sides also have a curved shoulder 228 which in combination with shoulders on neighbouring teeth define a generally cylindrical face for the breaker drum assembly.

CLAIMS

1. A tooth construction for a mineral breaker of the type having at least one breaker drum from which breaker teeth project, the drum being rotatable in a given direction to effect breakage of mineral, the tooth construction including a tooth core upon which is mounted a tooth cap assembly, the tooth core having a terminal end having opposed front and rear faces spaced along said given direction and a bore extending between said front and rear faces, the tooth cap assembly including an anchor member extending along and being immovably connected to the core by being held under a tensile loading by clamping abutment against said front and rear faces, the anchor member having first and second mounting portions which project beyond said front and rear faces respectively, the tooth cap assembly further including a tooth cap which overlies the terminal end of the core which extends between said front and rear faces, the tooth cap being immovably secured to said first and second mounting portions.

2. A tooth construction according to Claim 1 wherein the anchor member comprises a shank portion integrally formed with a collar, said shank portion extending through said bore and said collar defining said first mounting portion.

3. A tooth construction according to Claim 2 wherein said collar has a clamping face for clamping abutment with said front face, said clamping face being formed by one axial side face of said collar.

4. A tooth construction according to Claim 2 or 3 wherein said

anchor includes a screw threaded portion formed on the shank portion at a location axially spaced from said collar, and a nut located on said screw threaded portion, the nut being arranged to clampingly engage against said rear face of the tooth core.

5. A tooth construction according to Claim 4 wherein a lock nut is located on said threaded portion in abutment with said nut, the lock nut being fixedly secured to said tooth cap.

6. A tooth construction according to any of Claims 2 to 5 wherein said shank portion is formed from a high tensile metal, such as high tensile steel.

7. A tooth construction according to any preceding claim wherein said anchor and tooth core have co-operating formations which act to prevent rotation of said anchor within said bore.

8. A tooth construction according to any preceding claim wherein the tooth cap is provided with a detachable tooth cap tip.

9. A tooth construction according to Claim 1 wherein the anchor member comprises a shank portion integrally formed with a collar, said shank portion extending through said bore and said collar defining said second mounting portion.

10. A tooth construction according to Claim 9 wherein said shank portion includes a screw threaded portion axially spaced from said collar, the threaded portion being screw threadedly received in said tooth

cap, the tooth cap having a clamping face for clamping engagement with said front face of the core.

11. A method of constructing a tooth construction according to Claim 1, the method comprising clamping the anchor to a tooth core and subsequently fixedly connecting the tooth cap to the first and second mounting portions of the anchor.

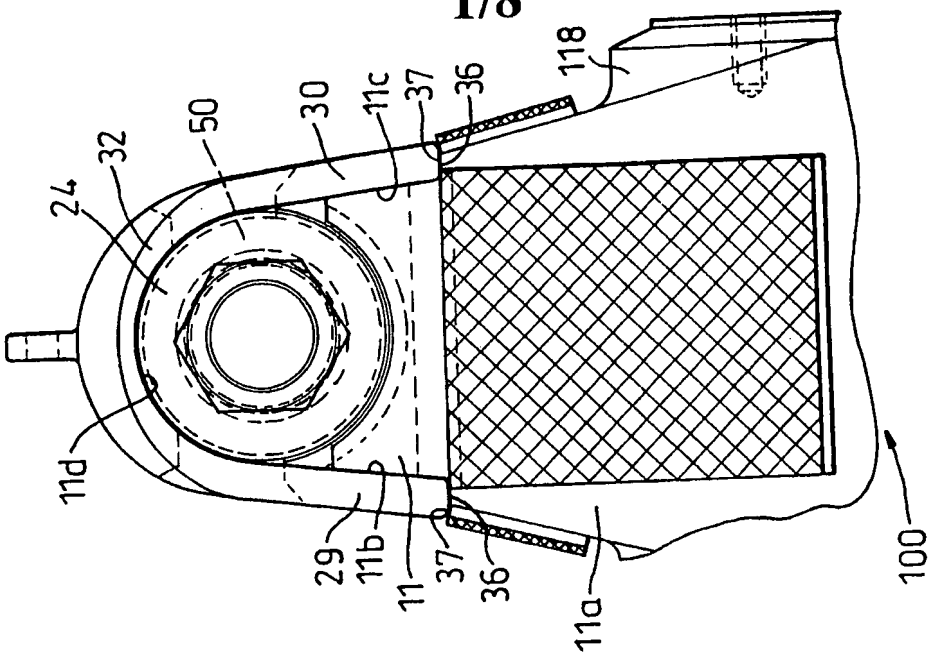

118
36
37
11c
30
50
32
24
11d
29
11b
11
37
36
11a
100

Fig. 2

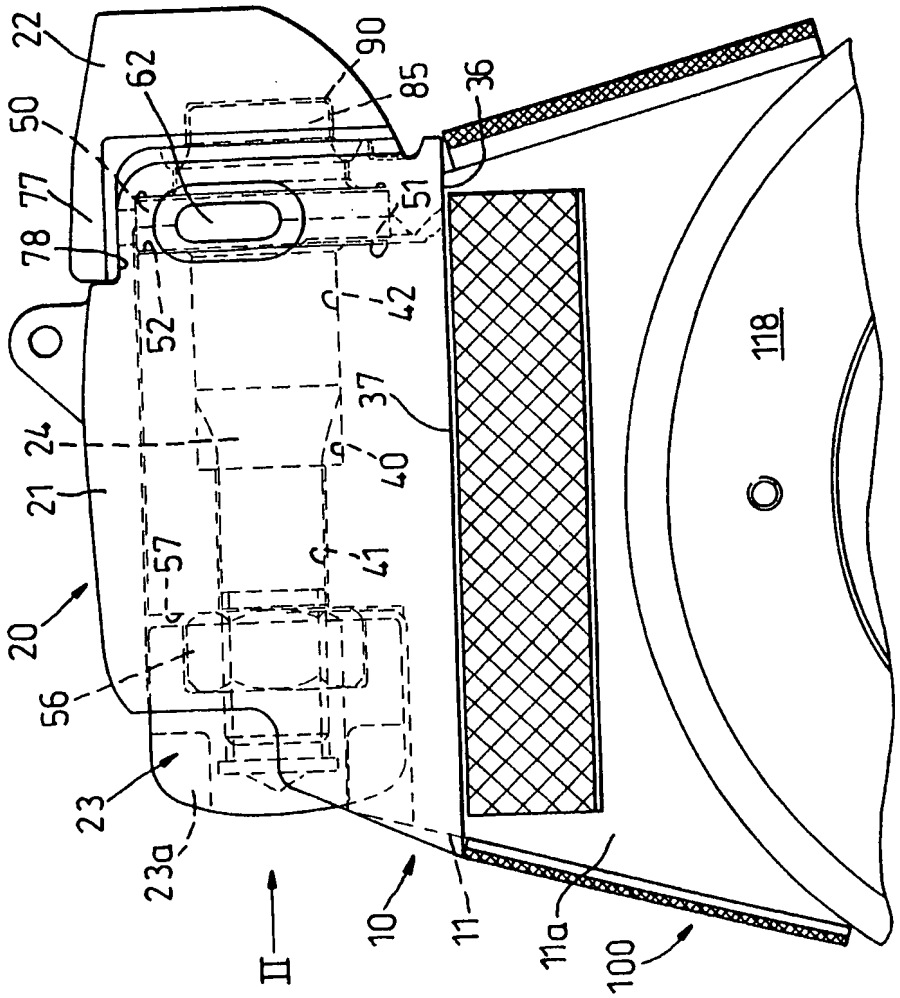

22
62
90
85
36
50
77
78
51
52
42
37
24
21
40
57
41
20
56
23
23a
II
10
11
11a
100
118

Fig. 1

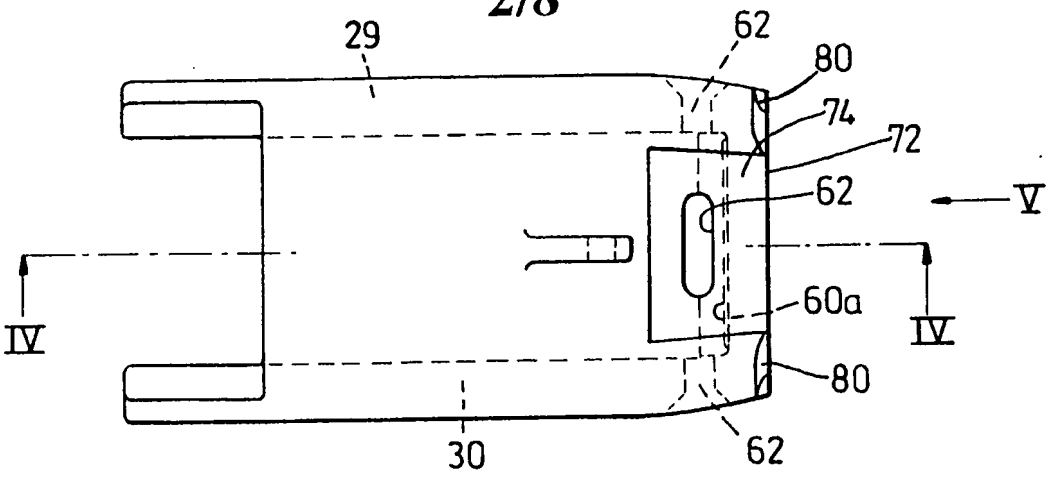


Fig. 3

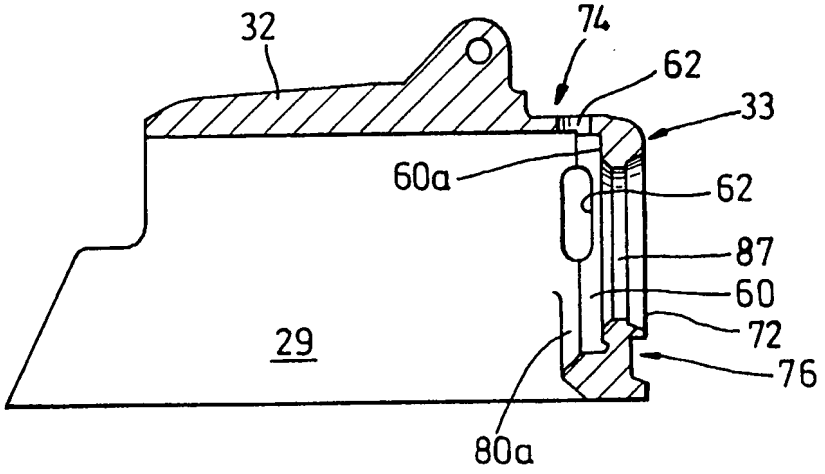


Fig. 4

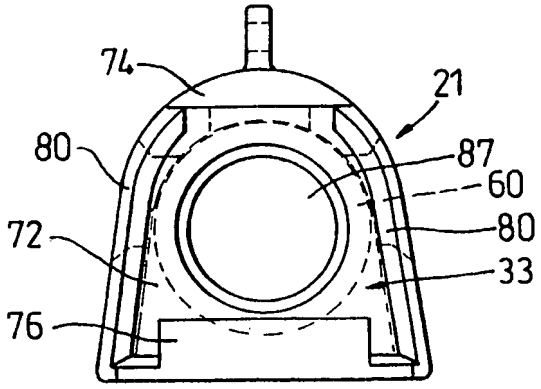


Fig. 5

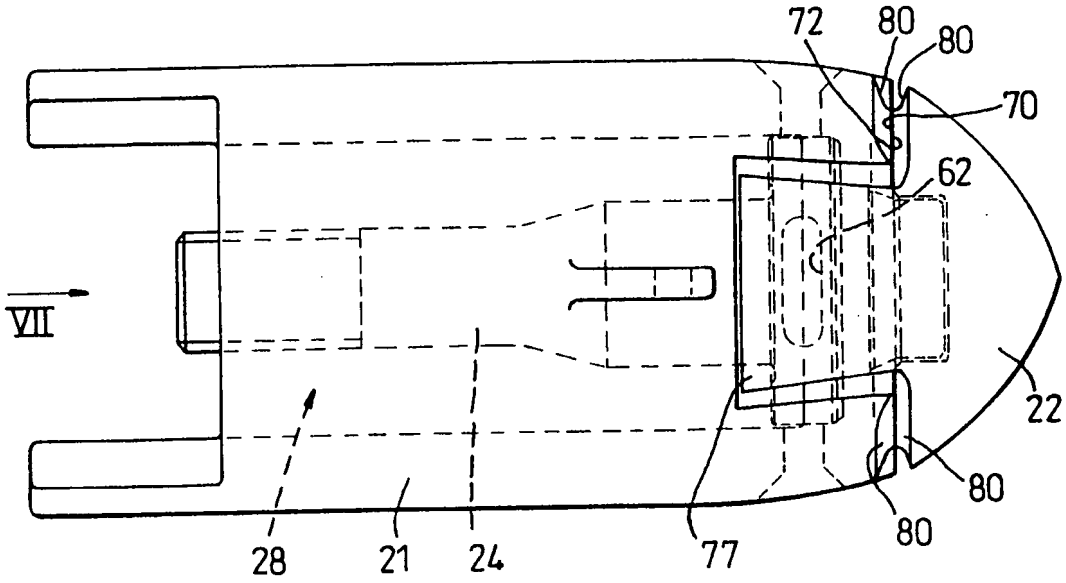


Fig. 6

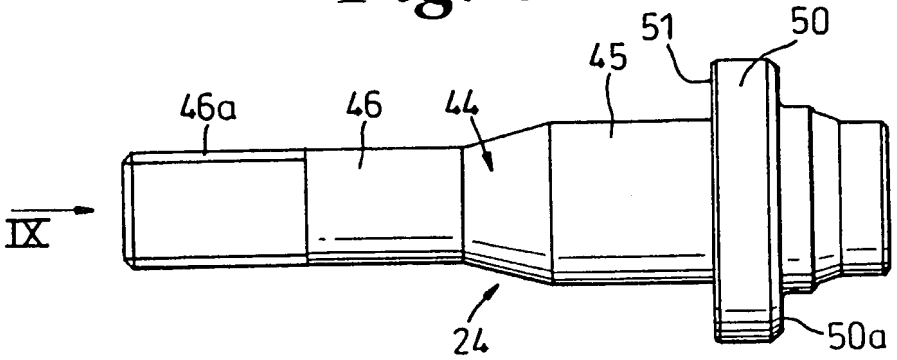


Fig. 8

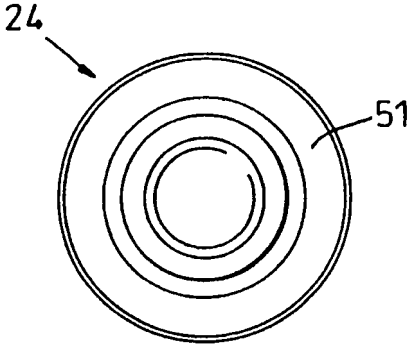


Fig. 9

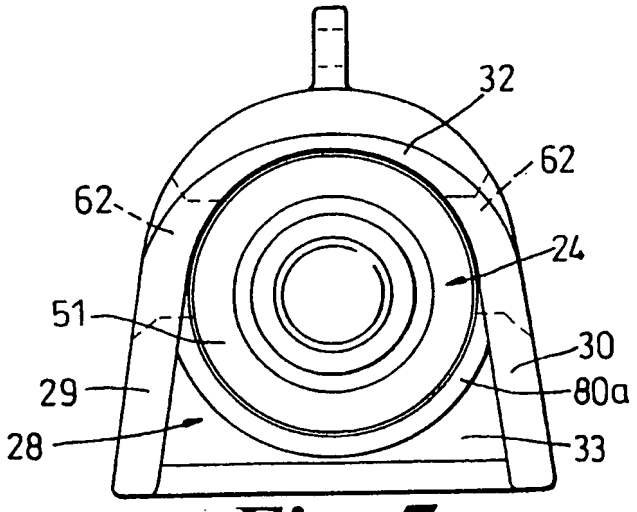


Fig. 7

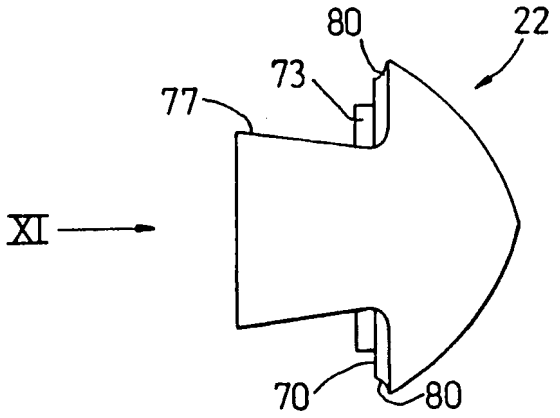


Fig. 10

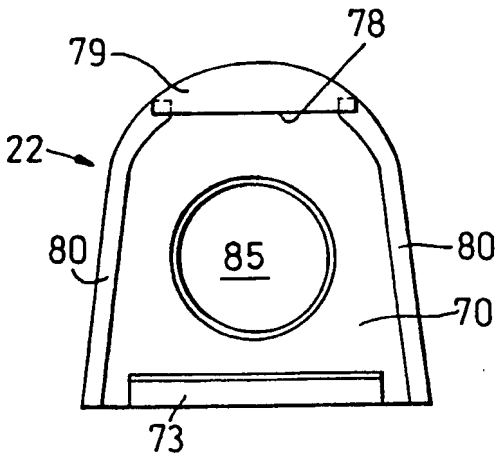


Fig. 11

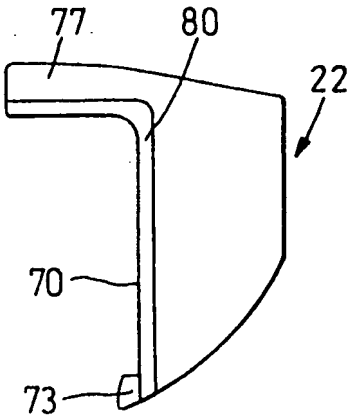


Fig. 12

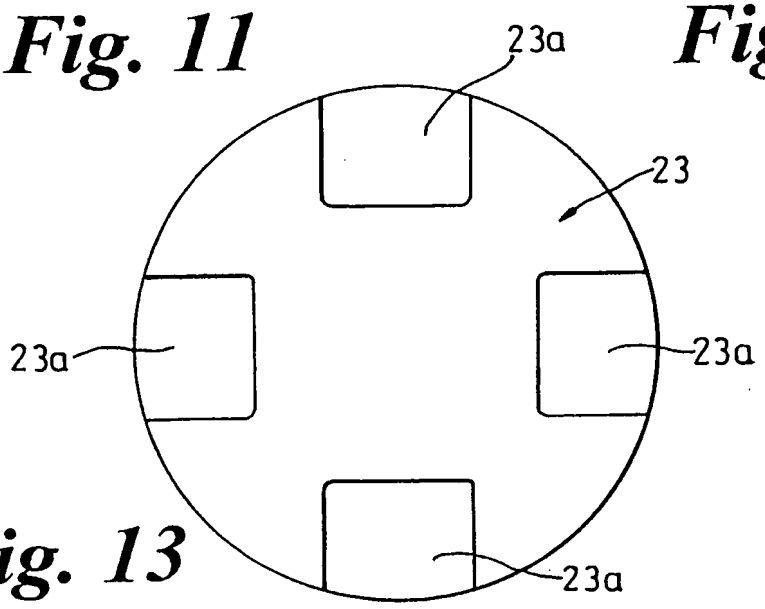


Fig. 13

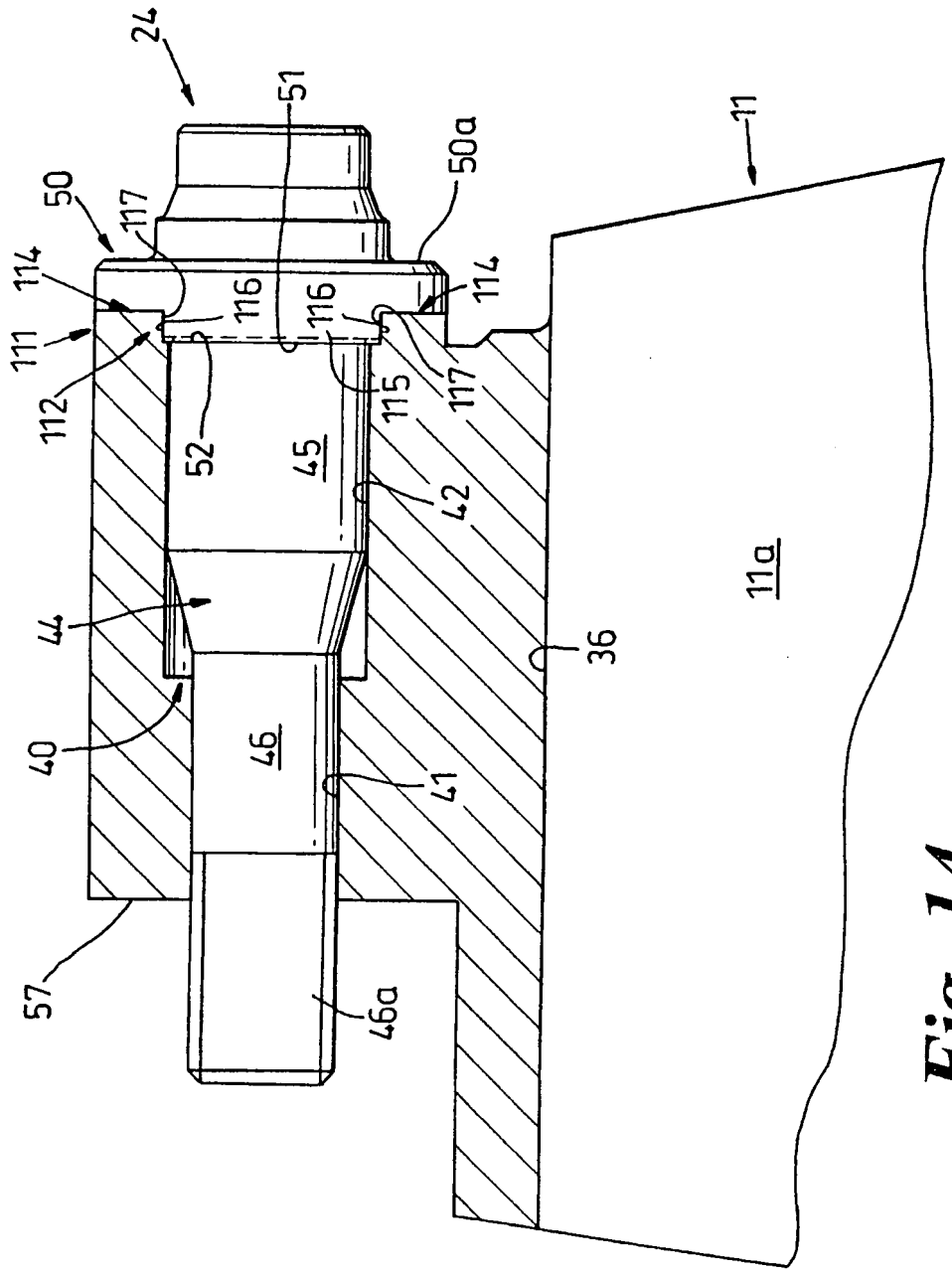

24
51
50a
11
50
117
114
116
116
114
111
112
52
45
115
117
42
11a
44
36
40
46
41
57
46a

Fig. 14

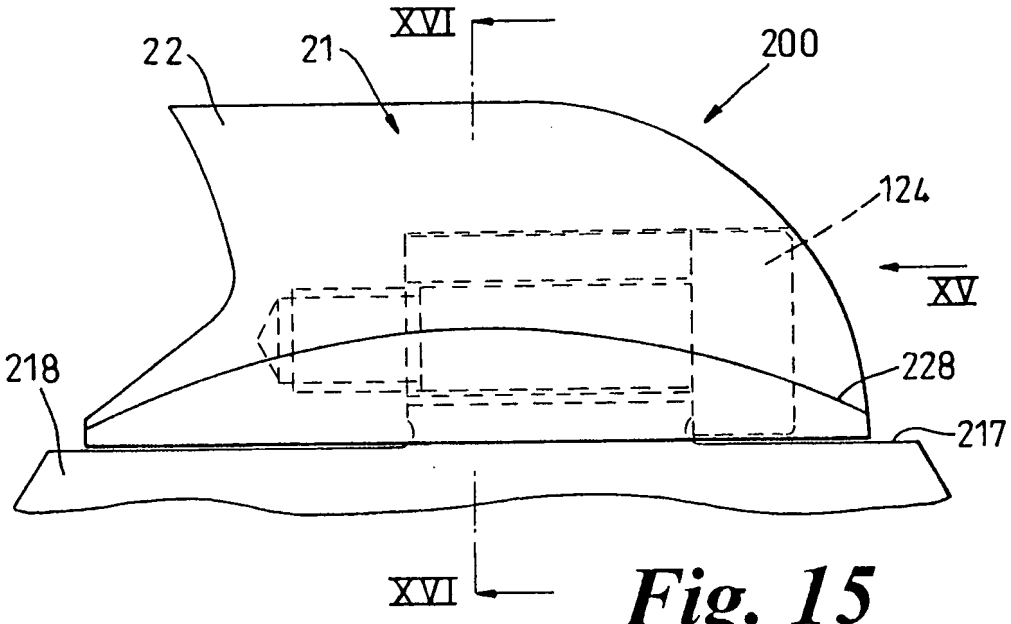


Fig. 15

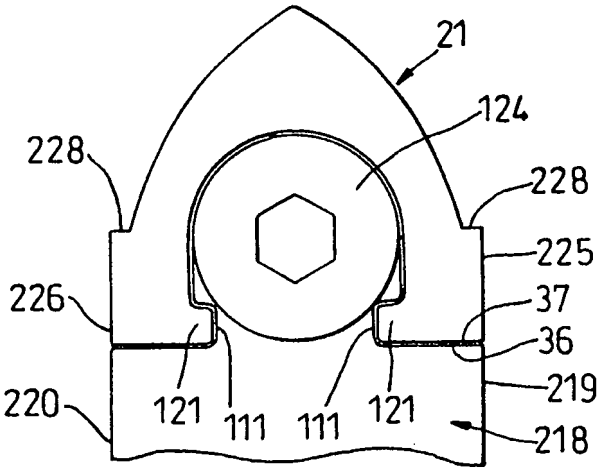


Fig. 16

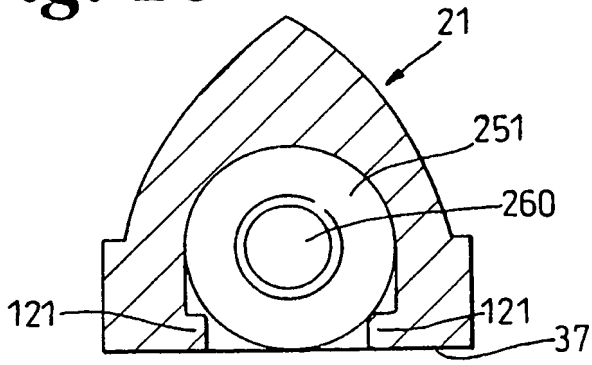


Fig. 17

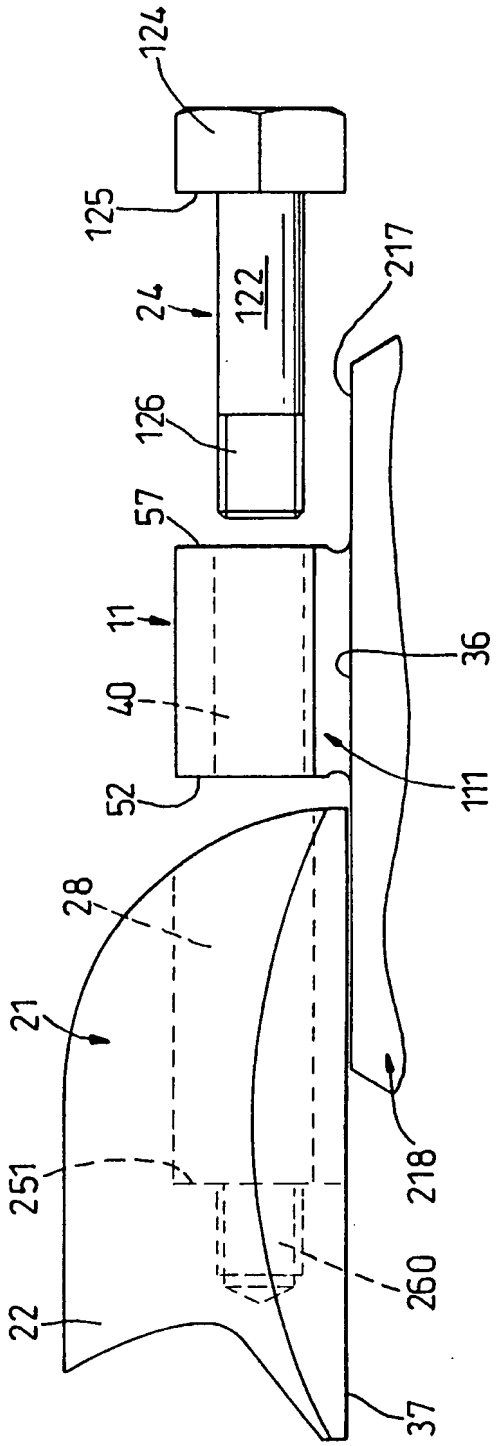


Fig. 18

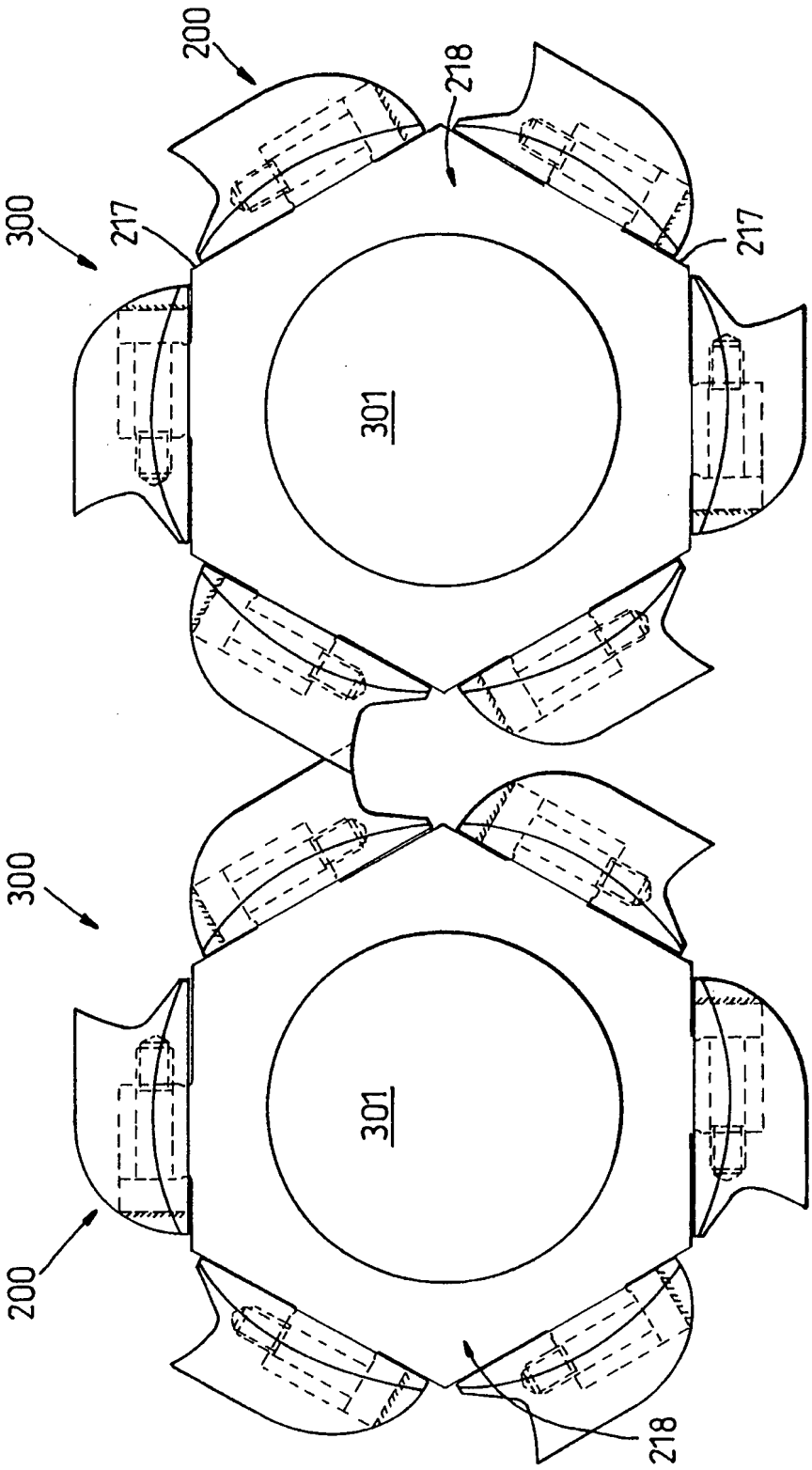


Fig. 19

INTERNATIONAL SEARCH REPORT

Int 'onal Application No
PCT/GB 98/01811

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B02C18/14 B02C4/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 403 694 A (MÜLLER GMBH. HERNE PUMPEN, MASCHINEN, STAHLBAU) 27 December 1990 see column 3, line 52 - column 5, line 26; figures 1-3 ---	1-11
A	WO 96 29149 A (MMD DESIGN & CONSULTANCY LTD.) 26 September 1996 see the whole document ---	1-11
A	GB 2 170 424 A (MMD DESIGN & CONSULTANCY LTD.) 6 August 1986 cited in the application see the whole document ---	1-11
A	WO 83 02071 A (MMD DESIGN & CONSULTANCY LTD.) 23 June 1983 cited in the application see the whole document -----	1-11

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 1998	05/10/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Verdonck, J

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int tional Application No
PCT/GB 98/01811

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 403694	A	27-12-1990	DE	3920305 A	03-01-1991
			AT	108094 T	15-07-1994
			DE	58908015 D	11-08-1994
			ES	2056178 T	01-10-1994
WO 9629149	A	26-09-1996	AU	5116296 A	08-10-1996
GB 2170424	A	06-08-1986	AU	583009 A	06-07-1989
			AU	582818 B	13-04-1989
			AU	5298386 A	14-08-1986
			CA	1266261 A	27-02-1990
			US	4781331 A	01-11-1988
WO 8302071	A	23-06-1983	AU	561740 B	14-05-1987
			AU	1106383 A	30-06-1983
			AU	593090 B	01-02-1990
			AU	7143287 A	03-09-1987
			BR	8208018 A	08-11-1983
			CA	1193586 A	17-09-1985
			DE	3278128 A	31-03-1988
			DK	373183 A	16-08-1983
			EP	0096706 A	24-02-1988
			EP	0167178 A	08-01-1986
			US	4799627 A	24-01-1989